



**Effect of Jigsaw method on students' scientific attitude in laboratory course:  
Comparison of Anderson-Rubin and raw factor scores**

*Research Article*

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**Abstract**

Aim of this study is to investigate the effect of Jigsaw on students' scientific attitude. Study design is qualitative methods' pre experimental nonequivalent groups posttest design. In this research design, pre-condition of the groups are unknown. Only the after condition of the groups are investigated and results are about after procedure. Sample of the study consisted of students who studied at elementary science education program. With respect to research design, students were divided randomly into two groups for laboratory course. First group studied with respect to Jigsaw method while second groups studied with respect to traditional method. After completing the semester students were asked to respond scientific attitude scale. Only volunteered students were involved in the study. Thus, sample of the study consists of 10 students from the traditional group and 17 students from the jigsaw group. Number of the sample is 27 in total. Non parametric analyses were run for group comparisons. Data for statistics are based on raw scale scores and Anderson-Rubin factor scores. Analyses results showed that there is no significant difference between the groups in terms of scientific attitudes. However, Anderson-Rubin factor scores gave more sensitive p value when compared with raw factor scores.

**Keywords:** Anderson-Rubin, Cooperative learning, Factor score, Jigsaw, Laboratory, Scientific attitude

**INTRODUCTION**

Students' attitudes towards science is an increasing concern in recent research trends since popularity of choosing a science related profession is seem to decrease. Because science is almost related to any profession and daily life activities then, the issue becomes a larger one on to debate. Additionally, choosing a profession is also related with attitudes. Thus, it is important to know students attitudes since it affects the behavior which was explained by theory of reasoned behavior (Baran et. al., 2019; Hagger, 2019; White & Harrison, 2012). Scientific attitude includes broad range of understanding or the cases such as effort to try and understand, questioning the statements, demand for verification and respect to logic (Grinnell, 2019). Behaviors affected by attitudes and peers might have effect upon each other' attitudes (Liu, Teng & Han, 2020; Osborne, Simon & Collins, 2003). Thus, it is important for teachers

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to know attitudes of students. For example, teachers exhibit scientific attitude tend to use teaching strategies and exhibit better teaching profession. Thus affecting positively their students' scientific attitude (Tiwari & Pathak, 2022).

Although many studies are done on effect of methods on academic achievement, few studies done on effect on attitudes (Osborne et. al., 2003). Osborne et. al. (2003) cite that knowledge is ephemeral while on the other hand attitudes are enduring and naturally have effects on acts. So, studies are done to determine the factors affecting the students' attitudes. There are several factors which affect the attitudes. For example, location of the house (city center, urban, rural etc.) have significant effect on attitudes toward science in favor of centered location housing. Similarly, socioeconomic status of students are also important (Yenice & Saydam, 2010). Another factor might be listed as educational settings. For example, Germann (1988) studied school assessment relationship with students' attitudes towards science in school achievement context. Study indicated positive relationship between assessment quality and science attitude. Same study also indicated that social and psychological factors such as enjoyment of classmates, school and class environment might be listed as other factors which are effective on attitudes. Even classroom organization is affective on scientific attitudes. (Olasehinde & Olatoye, 2014; Sevim, 2020). Effect of program is also effective on science attitudes (Fernández-Cézar, Garrido & Solano-Pinto, 2020). For that reason, teaching methods used in the classroom are also important because learning environment is one of the main issues shaped by the teaching methods and hence by the teachers (Mukhopadhyay, 2004).

Effects of teaching methods on both academic achievement and scientific attitude are constantly examined by researchers (Lee & Lee, 2016). For example, problem based learning affects students' scientific attitudes positively (Effendi, Firdaus & Erwin, 2018). Similarly, inquiry based teaching methods could also help students to increase their students' critical thinking skills and scientific attitude (Hastuti, Nurohman & Setianingsih, 2018). Other researchers try to develop new methods or improve existing ones to increase scientific attitudes of students (Dwianto et. al., 2017). Although some of the researchers could not verify the relationship between scientific attitude and science process skills, they indicated that concept comprehension is significantly and positively related with scientific attitude (Sari, Sudargo & Priyandoko, 2018). Other studies investigated relationship of classroom size with scientific attitude and found no relationship (Min & Yoo, 2017). However, other researchers indicate that with a small sized classroom, alternative teaching methods could improve students' scientific attitudes of gifted students, scientific self-efficacy and creative problem solving (Jeong & Lee, 2018).

Literature stated above indicates methods might be affective on students' scientific attitudes. In addition, cooperative learning method is one of the active learning methods which creates a pleasant learning environment (Keramati & Gillies, 2022; Purwanto et. al., 2020). Thus, purpose of this study is to investigate effect of cooperative learning method on students' scientific attitude. For that reason, jigsaw method which is one of the cooperative learning method is implemented for the study.

Thus problem state of the study is

1. What is the effect of jigsaw method on students' scientific attitude?

Sub problem of the problem state is

1.1. Does Anderson-Rubin and Raw factor scores differ in terms of statistical values?

## **METHOD**

### **Research design**

Study design is qualitative methods' pre experimental nonequivalent groups post test design. In this research design two groups are selected as randomly and effect of variable is investigated. In this research design, pre condition of the groups are unknown. Only the after condition of the groups are investigated (Karasar, 2009). In this case, the investigated after condition was students' scientific attitude. Variable was jigsaw instructional method which was used for the study.

### **Research sample**

Sampling method used for the study was convenience sampling since sample was drawn from available population (Simkus, 2023). Sample of the study consisted of students who studied at elementary science education program.

### **Procedure**

Students were randomly divided into two groups. One group studied chemistry laboratory with respect to traditional method. Laboratory instructor introduced the subject material. Explained what was being expected from the students. Demonstrated an example experiment and asked students to carry out the rest of the experiments.

Other group studied chemistry laboratory with respect to jigsaw technique. For that reason, students were randomly distributed into groups. Those groups were called as main groups. Each student in the main group was assigned to a different subject topic. After that, students in similar subject topics come together and created a new topic. Those groups were called as expert groups. Students in expert groups studied same topics together. After comprehending the material, those students returned to their original groups and carried out experiments with their original group members.

At the end of the semester, students in both jigsaw and traditional groups were asked to respond a scientific attitude scale voluntarily. For that reason, only volunteered students responded to scientific attitude scale. Since sample only consisted from the volunteered students, 27 students were involved in the study. 10 students from the traditional group and 17 students from the jigsaw group were involved in the study.

### **Data Analysis**

Data collecting instrument was scientific attitude scale developed by Akkuş (2019). Original scale has .953 Cronbach's  $\alpha$  value and internal consistency of this study was found as .840 which is "highly reliable" (Kalaycı, 2010). Scale has 21 item and lowest raw score might be obtained from the scale was 21 and highest score might be obtained from the scale was 105.

Thus raw factor scores was calculated with respect to based on scale points for the groups. For a second analysis, factor scores were calculated with respect to Anderson-Rubin (A-R) method. A nonparametric independent samples test was run due to number of the sample. Analyses were carried out for the groups and results are obtained with respect to both raw scale scores and A-R factor scores of the groups. Results of the analysis are given in Table 1.

**Table 1.** *Mann Whitney U test results*

	Group	N	Mean Rank	Sum of Ranks	U	Sig.
Raw Factor Scores (R)	Jigsaw	17	13,74	233,50	80,5	,821
	Traditional	10	14,45	144,50		
A-R Factor Scores (A-R)	Jigsaw	17	13,35	227,00	74,0	,581
	Traditional	10	15,10	151,00		

Data in Table 1 indicates there is no statistical difference between the groups with respect to both raw factor scores ( $U_R=80,5$ ,  $p=.821$ ) and A-R factor scores ( $U_{A-R}= 74,0$ ,  $p=.581$ ).

## DISCUSSION

Group's scientific attitude comparison with respect A-R scores and raw scores indicated that scientific attitudes between the groups were not significant. On the other hand it, is noteworthy that significance between the groups tend to increase for A-R scores since p value tends to decrease. Factor scores based on A-R method provided a p value of .581 which is lower than p value of raw scores (.821). The reason for that, in raw factor score method items in a factor are given the same weight where in A-R factor score method items' weight depends on their loading in a factor (DiStefano, Zhu & Mindrila, 2009). For that reason, calculating factor scores and applying tests would provide more accurate results. On the other hand, significant value might not be obtained since laboratory courses increase the positive attitude of students regardless of the teaching method (Nasution, Jalmo & Yolida, 2014). For that reason, scientific value of the students in both groups might have also increased. Alghamdi (2017) proposed that traditional approach in laboratory courses provide higher positive attitudes towards science when compared to Jigsaw method. Due to research design, further claims might not be made for this study because pre-study condition of the students are unknown. However, studies indicate that cooperative learning methods have positive effect on academic achievement and has a natural effect on increasing scientific attitudes of students (Putri, Citra Wibawa & Widiana, 2018). Students who have more positive attitudes towards science also have better academic achievement (Mehtar & Singh, 2018). Scientific attitude is one of the factors which affect students' academic achievement as shown by some researches (Kristiani et. al, 2015).

### Limitation

Sampling method and sample size is this study's limitation. For that reason, with a different approach both in research design and in sampling might provide more insight for the investigated issue.

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